

MECHANICAL ENGINEERING.

A Text-book of Mechanical Engineering. By Wilfrid J. Lineham, Head of the Engineering Department at the Goldsmiths' Company's Institute, New Cross. (London: Chapman and Hall, Limited, 1894.)

MR. LINEHAM says that the desirability of writing his book was suggested to him by the initiative of the City and Guilds of London Institute in providing an examination in mechanical engineering. In preparing students for this examination he was led, he says, "to consider seriously (1) whether the whole theory and practice of mechanical engineering, or even a *précis* of it, could be compressed into one volume; and (2) whether it was desirable so to compress it." After examining Mr. Lineham's book, we must confess to feeling grave doubt whether the second question, at least, should not have been answered in the negative before he set about the execution of so very large a task. The ambition of the attempt is, perhaps, more conspicuous than its success; at the same time the book has good features, and students of engineering may learn from it much that will be valuable to them. It is a novel contribution to engineering literature; by no means wholly satisfactory, but still one that should take a useful place.

Mr. Lineham deprecates in advance the criticism which he expects will be made on the compression of a vast subject into a single volume, by citing "the examples of great and successful writers—to wit, Rankine, Ganot, Deschanel, and others." We do not know whether both adjectives are intended to apply to Ganot and Deschanel, who, in any case, did not write on a subject which has a practice as well as a theory. As to Rankine, who certainly did write great and successful treatises on engineering, the citation seems particularly unfortunate. To compress everything into one volume was exactly what Rankine did not do. He wrote four or five large books dealing with various branches of the subject, and did not hesitate to repeat certain portions in more than one book whenever that was necessary to make each intelligible apart from the rest. Rankine's method and the author's are as wide apart as the poles; and of the two we prefer Rankine's. Moreover, Rankine, in his great series of text-books, dealt almost wholly with the *rationale* of engineering; but here, in a single volume, more than half the space is occupied by a description of the processes of the workshop.

It is in the descriptive portions that Mr. Lineham is at his best. Probably no better general account of hand and machine tools, and of the way to use them, has been published. The pattern shop and foundry, the smithy, the machine shop, fitting and erecting shops, all come in for their due share of attention. The construction of a horizontal engine is selected as a typical case, and is described from start to finish with minuteness of detail and with the aid of many admirable drawings. The illustrations of the book are indeed excellent throughout, both in style and matter. They are illustrations that really illustrate. There are 732 of them, and all are engineers' drawings. They have been prepared with obvious care, and it would seem with unsparing labour on the author's own part. They are treated in a way which allows of their liberal introduction without much

expenditure of space. In a word, they are everything that the illustrations in such a text-book ought to be. The descriptive section of the book concludes with a useful chapter on boiler-making and plate work, with a somewhat extended account of hydraulic rivetting processes, and with a short notice of electric welding. In setting forth so much descriptive matter as this first part includes, it is of course difficult to preserve in all parts a proportion to which exception may not be taken. We could wish to have seen more space given to the milling processes, which take so prominent a place in modern workshops. Nine or ten pages for hydraulic rivetting, and a mere page and a half for the universal milling machine, seems less happy a proportion than the author has generally maintained. This, however, is a small matter; and it may safely be said that any engineering pupil or apprentice will have his outlook widened, and his knowledge considerably increased, by reading the first part of Mr. Lineham's book.

To the study of the second part, however, he will do well to bring some independent criticism. The first chapter is on the strength of materials, and we had not penetrated far without finding the ground shaky. Dealing with the nature of shear stress, the author uses the symbols f_t , f_c , and f_s to indicate intensities of tensile, compressive, and shearing stress respectively, and resolves shearing stress into normal stresses inclined at 45° to it by the equation

$$f_c^2 + f_t^2 = f_s^2$$

$$f_c \text{ or } f_t = \frac{f_s}{\sqrt{2}} = \frac{f_s}{1.414}$$

This is a bad start in a chapter which is to include references to such subjects as the strength of thick cylinders, the torsion of square shafts, and the effects of combined bending and twisting in crank-shafts.

Immediately after this error is the following paragraph:

"On account of the cup or wedge fracture exhibited when a specimen is broken by tearing or crushing, and for other reasons, Prof. Carus-Wilson argues that rupture takes place by shear stresses at 45° , either wholly or partially. Certain it is that the three stresses are intimately connected, and assist each other in destroying the cohesion of the particles."

We have not an intimate acquaintance with the contributions which Prof. Carus-Wilson has made to this subject; but there is no evident reason why his authority should be invoked in support of an idea which is surely as old as the testing of materials.

Turning to the paragraph headed "Strength of square shaft," we find a geometrical construction described at some length, which is apparently based on Coulomb's erroneous theory. The student who has taken the trouble to follow this will feel excusably confused or irritated when he goes on to read the subsequent lines:

"St. Venant showed, however, in 1856 that Coulomb's ring theory was not strictly applicable to any but circular sections, and gave the following:

$$\text{Moment of square section} = f_s (2.085r^3)$$

because the greatest stress does not occur at the corners. To illustrate St. Venant, Thomson and Tait have

imagined the shaft to be a box full of liquid, which, if rotated, would leave the latter behind somewhat, and the apices would cause two stresses—tangential and centripetal—to act on the particles, the former only being of momental value.”

Now what is the student, whether at the New Cross Institute or elsewhere, to make of this without further explanation? To introduce St. Venant and say no more than this, is surely giving either too much or not enough. The same criticism might be repeated at many other places. Under the heading of “Pillars and Struts,” we are told that Euler is pronounced Oiler (this, at least, is nothing if not practical), and his formula for the stability of long columns is quoted without explanation. Gordon’s formula and constants are also quoted, and the subject is dismissed with the dictum :

“Claxton Fidler says a pillar-strength cannot be an absolute quantity, but may be anywhere between Euler and Gordon’s results.”

The theory of heat engines is treated in an equally scrappy and inconclusive fashion. The student will not find it easy to reconcile what he is told on p. 609 as to the efficiency of the engine not depending on the working substance, with the statement, on p. 613, that “in practice it is difficult to find a sufficiently perfect substance”—which is given as a reason why the efficiency of a real engine is less than the efficiency in Carnot’s cycle. He will find himself also at a loss to understand the statement that “in adiabatic expansion external work is done at the expense of internal heat, and is therefore negative”; or to see why the dryness fraction of steam is necessarily “a whole number” (p. 594). Again, to take a matter of first-rate importance in regard to the action of steam in the cylinder, initial condensation is spoken of as if it affected the efficiency merely by the trifling alteration it produces in the form of the expansion curve, and we do not find a hint as to the real reason for its highly prejudicial effect.

It would be unfair to conclude that all the theoretical portions of the book are equally unsatisfactory. But at the best, their brevity, and the narrow limits of mathematical knowledge which the author assumes on the part of his readers, make this part of the work more like an engineering pocket-book than a treatise, the purpose of which ought to be to educate the student to reason about the application of mechanical principles to engineering. If the book, in this aspect, is representative of the teaching which the new Polytechnics are giving, it suggests the inquiry whether what Lord Armstrong once called “the vague cry for technical education” has met with the best possible response. We have no sympathy with those who would exclude either engineer apprentices or any other workmen from the highest education they are capable of. But the question may fairly be asked whether a good deal of what is apparently taught, and taught for the express purpose of enabling pupils to pass a specified examination, is in any just sense education at all. The mental discipline which would be obtained by making a real study of problems such as are touched on in this book, would be of the highest value as an education to the engineer. But there is no royal road to the comprehension of elasticity and thermodynamics.

If the young apprentices and working lads, who, much to their credit, flock to the new Polytechnics, will take the trouble to truly master any of these things, they will gain an intellectual possession which will make them better men, if not directly better workmen. We would be the last to set a bound to their aspiration, or to discourage the study of Euler and St. Venant. But as a preparation for any such task, they must first, let us say, learn what is the meaning of a differential coefficient. To offer them scraps of conclusions which have to be taken on trust, and “reasons” which can carry conviction to no one except perhaps a jaded examiner, is giving stones to children who presumably cry for bread. If this represents the “theoretical” side of technical education as the new technical schools understand it, or as examiners accept it, we are still some way from a satisfactory solution of the much-vexed problem. For a great deal of this does not usefully instruct, and does not effectually educate: it is, as we have said, either too much or not enough.

THE LAKE OF GENEVA.

Le Léman Monographie Limnologique. By F. A. Forel. Tome second. (Lausanne: F. Rouge, 1895.)

THE first volume of Prof. Forel’s work on the Lake of Geneva appeared in 1892, and was reviewed in these pages (vol. xlvii. p. 5). It dealt chiefly with the physical history of the lake-basin, while the present one, containing parts 6–10 of the whole work, begins with “Hydraulics,” or the currents, waves, *seiches*, and other deviations of the surface from the normal form of a fluid at rest. It passes on to thermal questions, such as the temperature at different depths, freezing of the surface, &c.; next to optical questions, such as the colour, occasional iridescence and other peculiarities of the water, and the phenomenon of the *Fata Morgana*; then to acoustics (briefly); and lastly, to the chemistry of the water.

As it is impossible, in the limits of a comparatively short notice, to deal with the numerous subjects included in the present volume, we shall restrict ourselves to those which, perhaps, may be more widely interesting than the rest. The first one concerns those curious oscillations of the level of the lake, which locally are called *seiches*. This phenomenon, as defined by Prof. Forel, consists in an alternate rise and fall of the surface of the water; the movement being roughly comparable with that of a balanced plank, when set swinging by a slight disturbance. These oscillations are more or less rapid; their amplitude varying much. Commonly it is only a very few inches; but it may amount, though rarely, to about six feet—the disturbance sometimes lasting for twenty or twenty-five minutes. The whole question is discussed by Prof. Forel in its various aspects, and a history given of the different explanations which have been advanced. He attributes it neither to the effect of storms, nor to that of wind, nor to that of varying atmospheric pressure, but to a disturbance of the whole mass of water by earth-tremors, and compares it to the effect which may be produced on a fluid contained in a flat dish by tapping the bottom. In this hypothesis, however, he frankly admits the existence of a difficulty; namely, that earthquakes and